A COMPACT SPIRAL T/R HF ANTENNA

This is a short, efficient, horizontal indoor spiral transmitting/receiving antenna, using 139 feet (approx. 42 m), that can be compacted into a length of about 15 feet (approx. 3 m). It is based on a pair of Slinkys. And, quite reasonably, you may ask "and what on earth is a Slinky?"

By Richard G. Marris, G2BZG

SLINKY was first met, by courtesy of the two sons of a colleague, while the author lived and worked in the U.S.A. for several years during the 1970's. Slinky is manufactured in the U.S.A. by James Industries Inc., Hollidaysburg, PA 16648. It consists of 90×2¾ in (90×7 cm) diameter turns of spring made of 67 ft (approx. 20 m) of flat bright steel wire. Each Slinky weighs about ½ lb (approx. 0.45 kg), and can be extracted to about 15 ft (4.5 m). However, it comes compressed into a 2¾-in (5.7-cm) length in a robust red carton on which we read that Slinky is 'a walking spring toy' for 'ages 6 and up!'. It was demonstrated to the author as a fascinating toy which would, among other things, walk down stairs!

Design background

It so happens that as a Slinky is expanded, it resonates as a ¼λ between 7 and 8 MHz. In fact, the retailers (Antenna West) offer suggestions, and kits of parts, for using it as a 7-MHz or 14-MHz delta matched dipole. Each dipole can be resonated by expanding or contracting the spring coil. It is estimated that the bandwidth would be comparatively narrow. Each kit comes with a Slinky, a transparent messenger line, transparent coil positioning tabs, ceiling hooks with hardware, transparent suction caps and white coaxial feedline.

Antenna description

The requirement was for a short efficient indoor multiband T/R antenna, which can be slung diagonally across a room, and used on most of the H.F. amateur bands.

As the primary, and lowest, frequency was for the 80-m (3.5-MHz) band, two Slinky coils (without accessories) were obtained, and electrically secured end-to-end. The long double Slinky was hung diagonally across a room, and end-fed with a short single feedline plugged into a suitable ATU (antenna tuning unit) which would resonate it on all amateur bands between 10 m (28 MHz) and 80 m (3.5 MHz). It was anticipated that the voltage and current distribution would be relatively uniform over the whole length, and that a sizeable section of each band could be used without retuning the ATU. As two coils weigh about 1 lb (approx. 0.9 kg), the whole spring was supported by thin nylon cord, enabling the antenna to be length adjusted, and compressed into a few inches when not in use. Also, it could be discreetly hidden in a corner of the room.

The final operating arrangement is shown in Fig. 1a, and the non-operational arrangement, in Fig. 1b. The 5-ft long feedline drops down from the room corner end, located over the equipment, the ATU. Various ATU types were tried, but the simple 'T' type shown in Fig. 2 proved to be the most effective. The earth connection was taken with about 15 ft (4.5 m) of stout

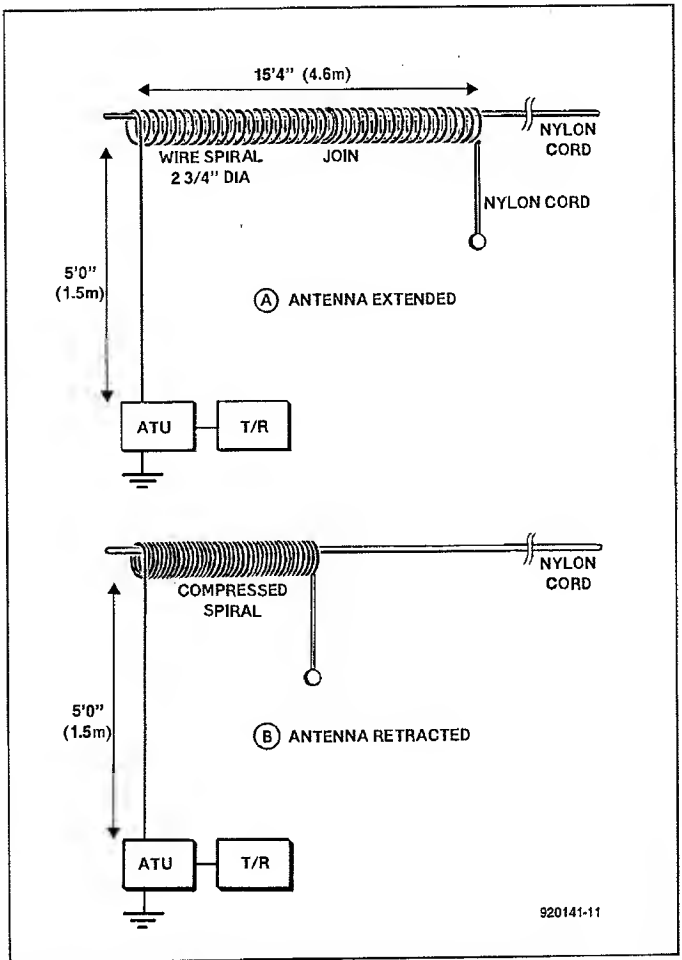

Fig. 1. The spiral loop hangs on a nylon cord attached to the apartment ceiling. Note: length difference between extended and retracted antenna is not to scale.

flex to a convenient water pipe. Though the final antenna is only 15'4" long (approx. 4.6 m), plus the 5-ft (1.5-m) drop-down feeder, there is actually a total of 139 ft (41.7 m) of wire, i.e., 2×67 ft plus 5 ft. The diagonal space across the room was 18 ft (5.4 m). The drop-down feedline is part of the antenna.

Antenna construction

A length of 1/16-in (1.6-mm) diameter white nylon cord is now suspended diagonally across the room, at least 9 ft (2.7 m) away from the ceiling, and carefully avoiding electric light fittings. Here, the length from corner to corner is 18 ft (5.4 m). The wire coil is now slipped over one end of the nylon cord, before it is securely fixed at one end. A stout 5-ft (1.5-m) long single-core flex feeder lead is soldered to one end of the coil, and dropped down to the ATU, as shown in Figs. 1a and 1b. A piece of nylon cord is tied to the other end of the coil, and terminated with a plastic ring or knob. By using this short nylon cord as a tow line, the coil can be expanded to a length of 15'4" (approx. 4.6 m), and a few turns of nylon cord wound and knotted at this point form an 'anchoring stop' for quickly expanding the antenna coil when in use. The last turn of the coil is slipped over this 'stop'.

When not in use, the coil can be pulled back to a discreet compressed coil at one end (see Fig. 1b). The horizontal length of nylon cord is nearly invisible against a white ceiling.

ATU construction

Possibly the reader has a suitable existing ATU, and this can be tried. Several ATU configurations were tried with the 'T' type, shown in Fig. 2, which was also the final design adopted. The inductor, L, is a length of B&W coil stock (see Components List), and C1 and C2 are both 250-pF good quality air-spaced variable capacitors. The whole is built into a convenient metal box, the maximum size of which will depend mainly on the type and size of the variable capacitor used. At least one diameter clearance should be left around L.

The spindles of C1 and C2 must be isolated from all metalwork. A convenient way of doing this is to mount C1, C2 and L on a sheet of perspex, or non-metallized fibre-glass board, which is mounted on four short pillars, just behind the metal front panel. Large clearance holes will be required in the metal box panel, so that the spindles of C1 and C2 do not touch the metalwork. Sockets Skt1 and Skt2 are coaxial types of convenient type to the user.

Taps should be made on L, for each band to be used. The ATU will match the antenna to the transmitter/receiver on the 80-m (3.5-MHz), 40-m (7-MHz), 20-m (14-MHz), 15-m (21-MHz) and 10-m (28-MHz) amateur radio bands. The author uses tapping clips, but some of you may prefer a ceramic wafer rotary switch. The method of locating the taps is described below.

Setting up, testing and operating

With the antenna extracted to 15'4" (4.6 m), and plugged into Skt1, and Skt2 connected to the transceiver with a short length of coaxial feedline, an earthing/grounding connection should be made to the ATU. Here, about 15 ft (4.5 m) of stout wire flex is firmly connected to a convenient metal water pipe. Other convenient grounding arrangements may be used depending on individual circumstances.

Do not connect the ATU to plastic water pipes, metal gas pipes, or metal electric wiring conduit. Do not connect it to the AC mains earthing pin either. Even though the mains earth will, no doubt, be connected to the transceiver, it must not be used as an RF earth connection to the ATU.

Tune the receiver to a convenient spot on the 80-m (3.5-MHz) amateur radio band. Set C1 and C2 to 50% capacity, and move the tap along the coil, L, for maximum signal. Adjust C2 for maximum signal — this will match the ATU to the receiver's input impedance. Next, repeat the adjustment of C1 for best antenna matching. Switch on the transmitter, and carefully re-adjust C1 and C2 for best loading and lowest SWR. Once you are satisfied with the results, secure the 80-m tapping point by either solder, switch or clip connection, depending on what has been decided. An SWR of 1:1 is obtainable with care. Repeat the process for the other bands selected.

It is also possible to match the ATU/antenna combination to Top Band (1.8 MHz), but it is presumed that performance would be suitable for the shorter range operation. It has not been tried.

As an example, the author has used this spiral antenna quite extensively, in the early morning, on the 80-m band, using a 14 watts input CW transmitter. An SWR of 1:1 has been achieved; no harmonics radiation or TVI detected, and the CW section of the band between 3.5 MHz and 3.6 MHz

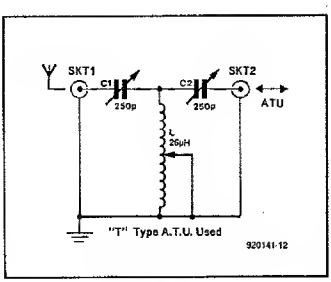

Fig. 2. Type 'T' ATU used.

COMPONENTS LIST

Antenna:
White nylon cord, approx. 1 mm diameter, DIY Stores (trade name in UK: Winchester)
Qty. 2 Slinky 2¾" diameter coils. Antenna West, 1500 North 150 West, Provo, UT 84604, U.S.A.

Note, at the time of writing, a Slinky coil (2¾" dia.) costs $10 each, plus $10 air mail (total $30). VISA and Mastercard accepted

ATU:
L = 26µH indutance, B&W no. 3059 (available in the UK from RF Engineering, Main Street, Coln-St. Aldwyns, Cirencester, Glos GL7 5AN.
C1 and C2 = good quality 250-pF single-gang variable capacitor, with knob.
Skt1, Skt2 = see text
Perspex or fibre glass board (see text).

can be used without retuning C1 and C2. The antenna appears to be omnidirectional, with near uniform current/voltage distribution along the whole spiral coil. Tests on other bands have been similar. The results with the antenna diagonally across the room, in a first floor room, have been very satisfactory. For anyone who has not the full required length available, it is suggested that part of the far end of the spiral be dropped down, or taken off at an angle.

Final considerations

The spiral antenna has been designed for use indoors. It could, of course, be used outside, but being made of bright steel, would quickly corrode. This problem could probably be eliminated by any reader who has facilities to degrease and marine varnish each turn, inside and outside, and between turns. At least two coats of varnish would be necessary for protection. An expensive, and, alas, somewhat specialized, alternative would be to chromium-plate the whole spiral coil.

Assuming that this antenna will be used indoors (as designed and intended), in the interest of safety, only low transmitting power should be used. Good quality air-spaced receiver-type variable capacitors for C1 and C2 should be satisfactory with transmitter output levels of up to 25 watts. ■

Useful reading

Antennas — 2nd edition, 1988, by John. D. Kraus (McGraw-Hill Book Company).
Antenna Book — 16th edition, 1991 (American Radio Relay League).
W1FB's Antenna Notebook — by Doug De Maw, 1987 (American Radio Relay League).